Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2012/025

REFERENCE POINTS FOR AMERICAN PLAICE (*HIPPOGLOSSOIDES PLATESSOIDES*) IN NAFO SUBAREA 2 + DIVISION 3K AND SUBDIVISION 3PS

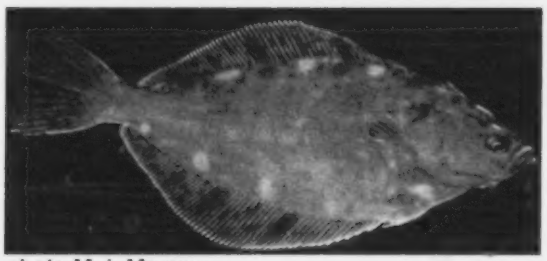

photo M.J. Morgan

Figure 1:American Plaice stock management areas SA2+Div. 3K, and Subdiv. 3Ps.

Context

Ecosystem and Fisheries Management has requested identification of reference points for SA2+Div.3K and Subdiv. 3Ps American Plaice stocks in order to apply the DFO Precautionary Approach (PA) framework (DFO 2009). The limit reference point and the upper stock reference will be used to define the Critical, Cautious and Healthy Zones.

This advice includes an updated assessment for SA2+Div.3K and Subdiv. 3Ps American Plaice stocks. Based on those assessments it provides biomass limit reference points for American Plaice in these two stocks. A removal reference point and suggested upper stock reference are also provided for Subdiv. 3Ps. Stock status relative to the limit reference points of the stocks is provided.

It is expected that the reference points described here will be in place until a substantive change in data availability or methodology warrants that these points be revisited.

November 2012

Canada

SUMMARY

Subarea 2 + Division 3K

- Total mortality due to all causes, including fishing, has been decreasing on more recent cohorts.
- In Div. 2J3K, an empirical biological limit reference point (LRP) was determined from examining stock recruit data from the RV survey. Generally recruitment has been impaired when the survey SSB index is below 70 000 t and therefore this was chosen as the LRP. It may be necessary to re-evaluate the LRP once more data are available at higher SSB (as SSB approaches the LRP).
- The 2009 estimate of survey SSB indicates that the stock is at 24% of the LRP. Estimates are not yet available for 2010 and 2011.
- It was not possible to determine an upper reference point or a removals (F-based) reference point for this stock.

Subdivision 3Ps

- A Bayesian Surplus Production Model was applied to catch data from 1960-2010 and survey data from 1980-2010 for American Plaice in Subdiv. 3Ps. Consistent with the DFO PA policy B_{lim} is 40% B_{msy}, the upper stock reference is 80% B_{msy} and F_{lim} is F_{msy}. Stock status relative to these reference points was estimated from the model.
- Stock size estimated from this model has been increasing slowly since 1993, however, current biomass is 50% of B_{lim} and therefore the stock is in the critical zone. The probability of being below B_{lim} is high (0.94). Current fishing mortality is estimated to be 64% of F_{lim}. The probability of being above F_{lim} is 0.2.

INTRODUCTION

History of the Fisheries

SA2+Div.3K

Landings increased steadily throughout the 1960s, peaking at about 13,000 t in 1970 (Figure 1), and were well below TACs for all years since 1982, where the TAC was > 0. TACs were drastically reduced in 1993 and again in 1994 just prior to a moratorium on directed fishing. After 1998 the TAC was 0.

Landings averaged about 2700 t over the 1980s and declined to near 0 after the cod moratorium of 1992. In most years landings have been less than 100 t since 1992 and since 2007 have been less than 25 t., which is by-catch in other fisheries. The main source of by-catch of American Plaice since 2000 has been in the Greenland Halibut gillnet and otter trawl fisheries. In 2010 and 2011 the total reported landings of American

Plaice were 22 t and 17 t, respectively. In both years 97% of the American Plaice by-catch came from the Greenland Halibut otter trawl fishery, mostly in Div. 3K.

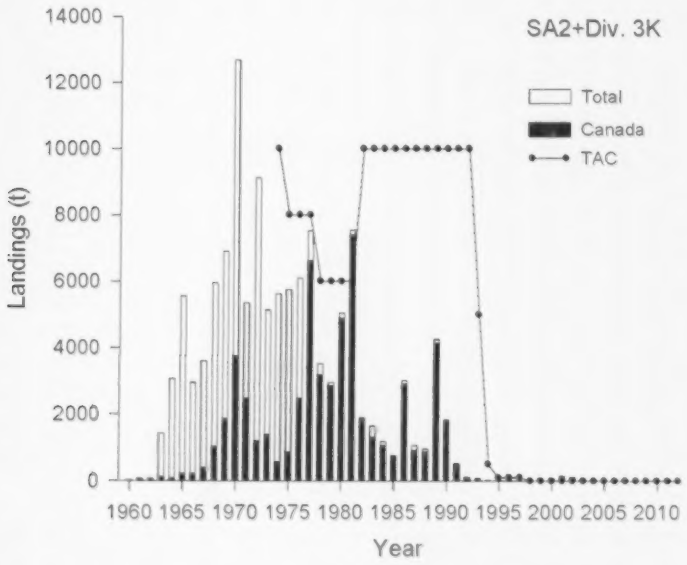

Figure 1. SA2+Div. 3K American Plaice catches (t) (1960-2011) and total allowable catch (TAC) (1974-2012).

There are discards of SA2+Div.3K American Plaice estimated from observer coverage from the shrimp fishery, mainly of fish less than 30 cm; however the magnitude of these discards is not known.

Subdiv.3Ps

Landings from this stock were highest from 1968 to 1973, exceeding 12,000 t on three occasions in this period (Figure 2). After the implementation of the 200-mile limit in 1978, landings ranged between 2,000 t to 4,000 t up to 1992. Subsequently, there has been a moratorium on directed fishing of American Plaice since September of 1993. Since then there has been only by-catch of American Plaice in other fisheries. By-catch increased substantially since 1995 and was over 1,000 t in each year from 2001 to 2003. However, by-catch has been declining since then and is 402 t and 273 t in 2010 and 2011, respectively. The by-catch of American Plaice is taken mainly in two fisheries, the directed cod gillnet and the witch flounder otter trawl fisheries.

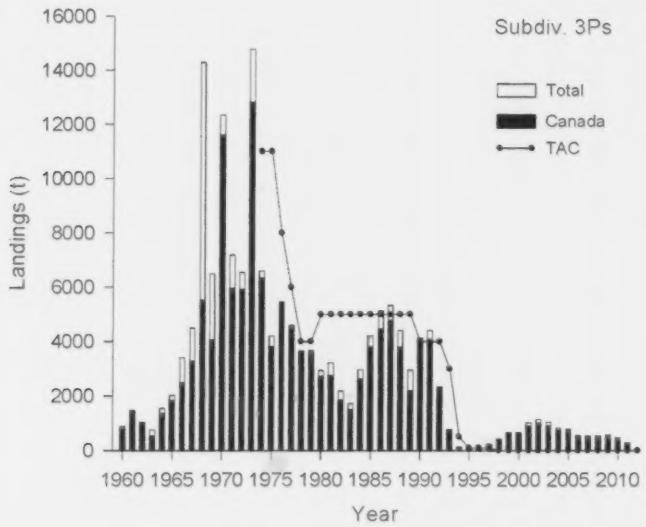

Figure 2. Subdiv. 3Ps American Plaice catches (t) (1960-2011) and total allowable catch (TAC) (1974-2012).

Species Biology and Ecology

American Plaice is a benthic marine flatfish with an elongated, strongly laterally compressed body. When young fish hatch from the egg at or near the surface they have the 'normal' fish orientation. During development they undergo a metamorphosis resulting in lateral compression and the head twisting so that they swim on their side and both eyes are on the upper side of the body, facing right. The eyed side is typically red to grayish brown and uniform in colour, whereas the blind side is white. The head is generally small but with a relatively large mouth.

American Plaice are usually considered a cold-water species with reported catches in temperatures from -1.5 to 13°C, but they are most numerous within a temperature range from just below zero to around -1.5°C. Once settled, adults and juveniles frequently inhabit the same areas over depths ranging from 20 to 700 m with a preference for depths in the range of 100 to 300 m.

American Plaice are generally a slow growing and moderately long-lived species that exhibit sexual dimorphism in that the females grow faster and are larger than the males for any given age. In SA2+Div.3Kspawning has been identified on Hamilton Bank, while in Subdiv. 3Ps it is widespread.

American Plaice are highly opportunistic feeders throughout their life cycle, feeding on whatever prey items are available in appropriate sizes for ingestion and varying with fish size, locality and seasonally. Adults and juveniles feed on polychaetes, echinoderms, molluscs, crustaceans and fish (capelin, sand lance, other flatfish, etc.).

ANALYSIS

Subarea 2 + Division 3K

Stock Trends

Stratified random bottom trawl surveys are carried out by DFO annually in the fall of the year. Biomass and abundance indices from these surveys in Div. 2H, although low, have been increasing since the beginning of the Campelen gear time series in 1996 (Figure 3).

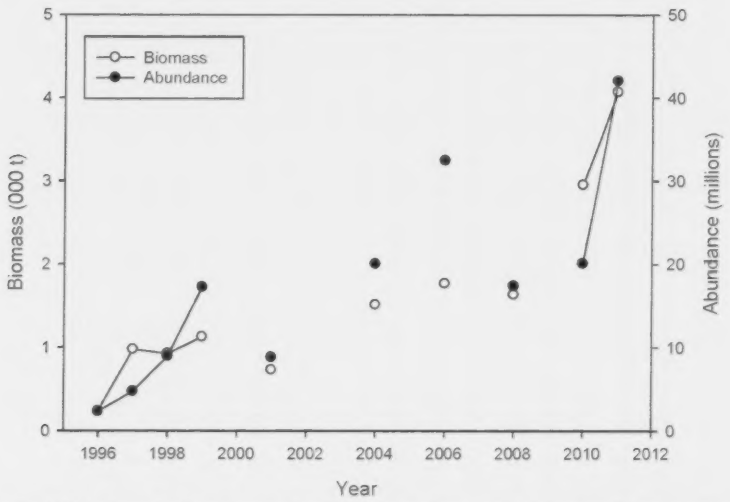

Figure 3. Biomass (000 t) and abundance (millions) indices of American Plaice from fall surveys, Div. 2H.

In Divs. 2J3K biomass and abundance estimates declined from the late 1980s to a low level in 2002. Since then both biomass and abundance have increased slightly. Abundance in 2011 is the highest since 1994 when the moratorium was instituted (Figure 4). However, current biomass in Div. 2J3K is at 10% and abundance at 25% of the average of the mid-eighties.

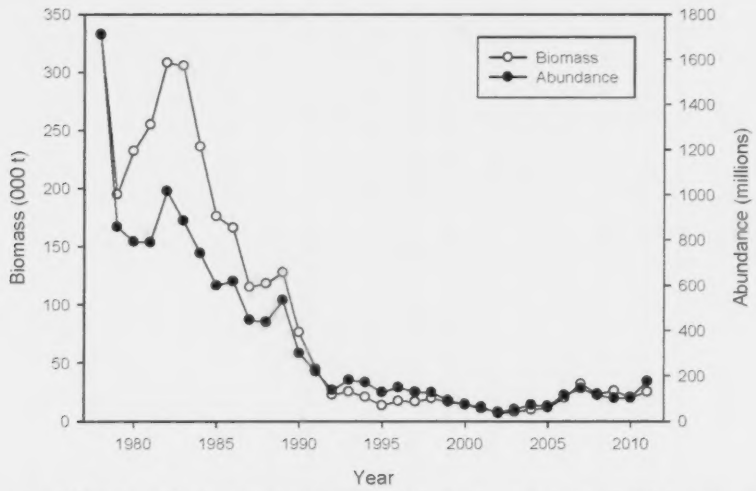

Figure 4. Biomass (000 t) and abundance (millions) indices of American Plaice from fall surveys, Div. 2J3K.

Biological Information

Mortality

A general linear model was fit to survey data for years 1978-2009 for ages fully selected to the survey gear (greater than age 6) and total mortality (Z) was estimated for cohorts. Total mortality due to all causes including fishing, has been decreasing on more recent cohorts (Figure 5).

Figure 5. SA2+Div. 3K American Plaice estimates of cohort total mortality (Z) based on the survey index. Higher values indicate increased mortality.

Maturity

Age and length at 50% maturity were estimated from DFO surveys. In SA2+Div.3K, age at 50% maturity (A_{50}) has declined from just under 11 years to around 7 years of age for females (Figure 6). For males, A_{50} has declined from around 7 to just over 4 years of age. Length at 50% maturity (L_{50}) has also declined for both sexes in SA2+Div.3K. For males, L_{50} was about 22 cm at the beginning of the time series and for recent cohorts is about 18 cm. Female L_{50} declined from about 38 cm at the beginning of the time series to about 31 cm recently.

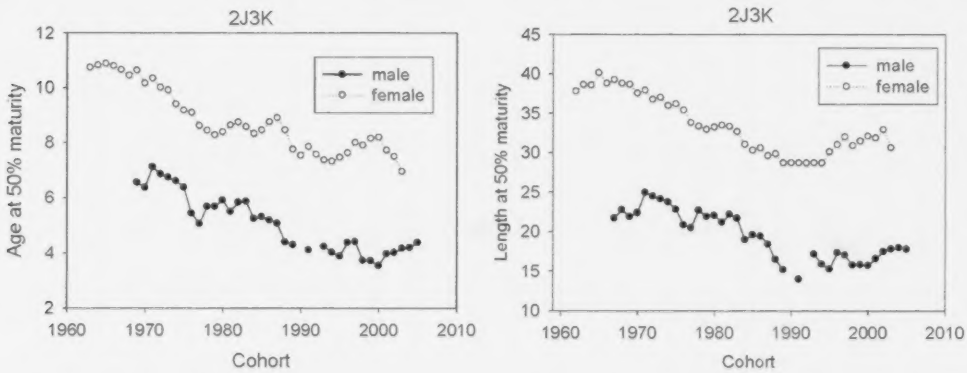

Figure 6. SA2+Div. 3K American Plaice age and length at 50% maturity.

Index of Spawning Stock Biomass (SSB)

An index of SSB in SA2+Div. 3K based on survey data declined rapidly after 1982 and reached its lowest level in 2003. There was some increase after 2006 but the average of 2007-2009 is only 15% of the average over the 1978-82 period (Figure 7). Ageing data has not been completed since 2009; hence the time series ends in 2009.

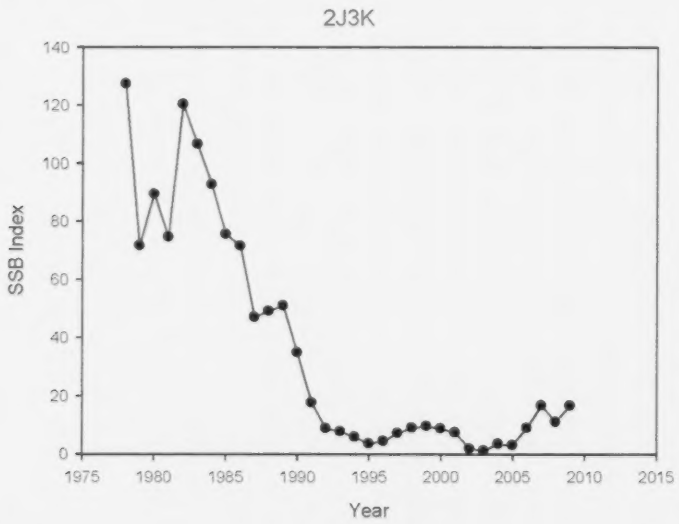

Figure 7. SA2+Div.3K American Plaice index of spawning stock biomass derived from research vessel surveys.

Recruitment

For SA2+Div. 3K a relative recruitment index was estimated from surveys using a general linear model applied to ages 3-5. Recruitment declined from the mid 1980s to the late 1990s. There has since been an increase in recruitment to approximately 40% of the average recruitment estimated prior to the mid-eighties (Figure 8).

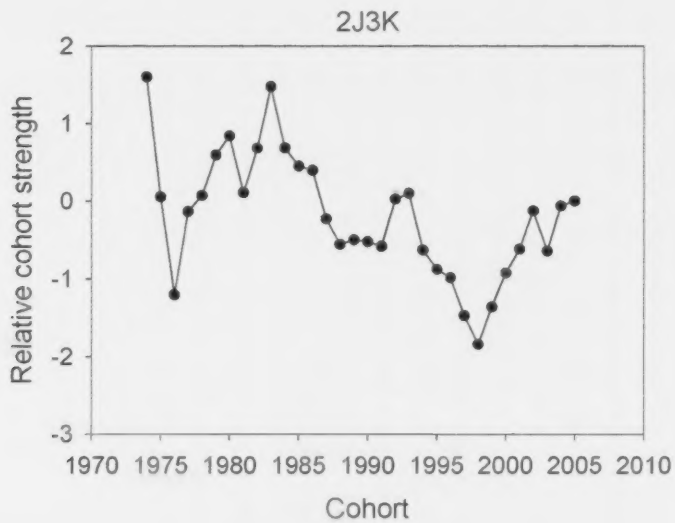

Figure 8. SA2+Div. 3K American Plaice recruitment as relative cohort strength estimated from research vessel data. Estimates are relative to the 2005 cohort.

Reference Points and Current Status

In Div. 2J3K, an empirical biological limit reference point (LRP) was determined from examining SSB from the RV survey and recruitment estimated from the relative cohort strength model. As the survey occurs in the fall the SSB index in year y was taken as giving rise to recruits in year y+1. Generally recruitment has been impaired when the survey SSB index is below 70 000 t and therefore this was chosen as the LRP (Figure 9). It may be necessary to re-evaluate the LRP once more data are available at higher SSB (as SSB approaches the LRP).

The 2009 estimate of survey SSB indicates that the stock is at 24% of the LRP. Estimates are not yet available for 2010 and 2011.

It was not possible to determine either an upper reference point, or a fishing or removals (F-based) reference point for this stock.

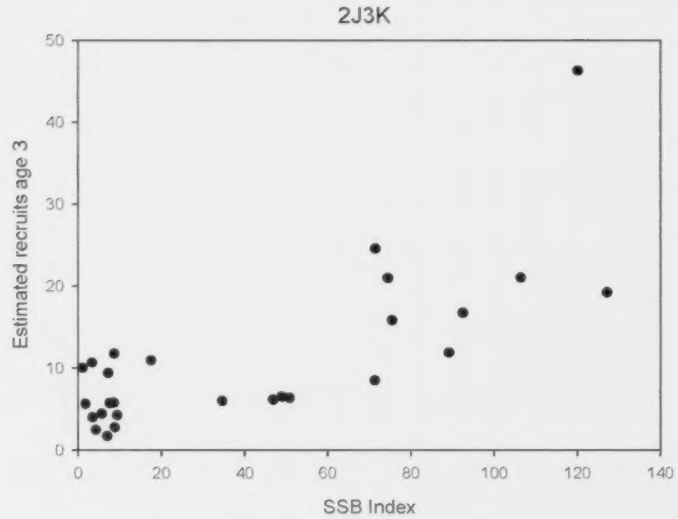

Figure 9. SA2+Div.3K recruitment and index of spawning stock biomass from research vessel surveys.

Subdivsion 3PS

Stock Trends

Stratified random surveys have been conducted by DFO in Subdivision 3Ps each year from 1972 to 2011. Prior to 1993 this survey timing was variable but generally took place in late winter. However, in 1993 there were two surveys, one in winter and one in spring. Since then the survey has taken place generally between late March and May. This survey was not completed in 2006.

Biomass and abundance indices from 1983-2011 are shown in Figure 10. From the mid-1980s to 1990 there was a large decline in both biomass and abundance indices. Stock size was lowest in the early 1990s. There has since been an increase over the 1992-2011 period for both biomass and abundance indices. However, current biomass is at 25% and abundance at 52% of the average of the mid-eighties.

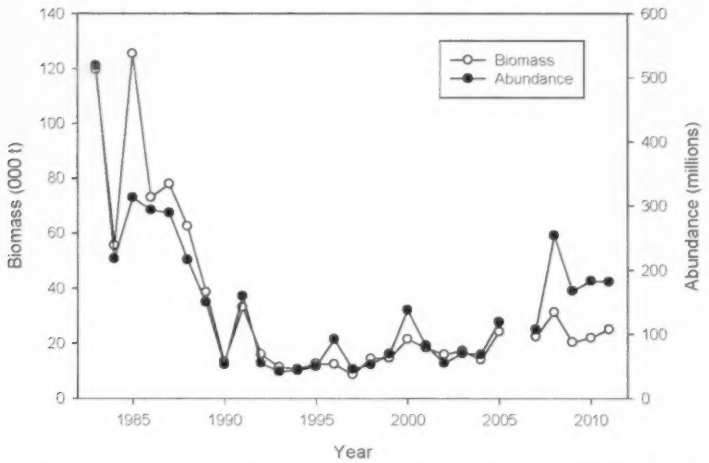

Figure 10. Subdiv. 3Ps American Plaice biomass (000 t) and abundance (millions) indices from spring surveys.

Biological Information

Mortality

A general linear model was fit to survey data for years 1983-2009 for ages fully selected to the survey gear (greater than age 6) and total mortality (Z) was estimated for cohorts (equivalent to catch curve analysis).

Total mortality due to all causes, including fishing, has been decreasing on more recent cohorts (Figure 11).

Figure 11. Subdiv. 3Ps American Plaice estimates of cohort total mortality (Z) based on the survey index. Higher values indicate increased mortality.

Maturity

Age and length at 50% maturity were estimated from research vessel data. In Subdiv. 3Ps male A_{50} has declined from about 7 to less than 4.5 years, while female A_{50} has declined from about 11 to just under 9 years. Male L_{50} has declined from about 27 cm to less than 19 cm and female L_{50} has declined from about 40 cm to around 36 cm (Figure 12).

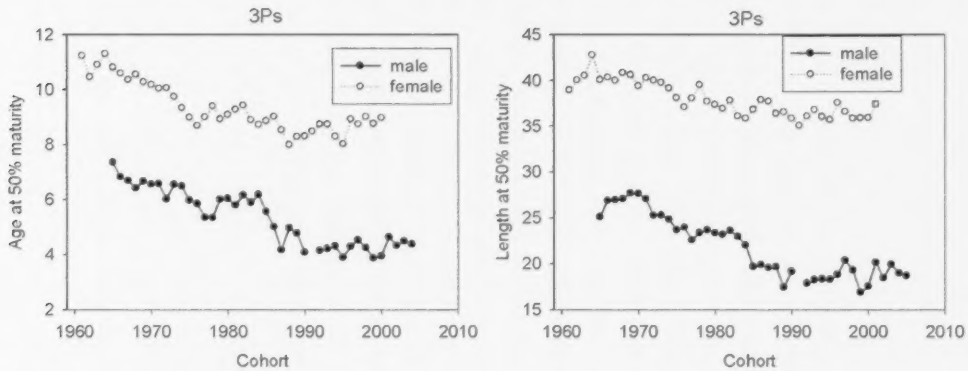

Figure 12. Subdiv. 3Ps American Plaice age and length at 50% maturity.

Index of Spawning Stock Biomass (SSB)

An SSB index based on Subdiv. 3Ps surveys showed a major decline from the mid 1980s to the early 1990s and has shown some increase after 1997. The SSB index from 2007-2009 is 30% of the 1983-1987 average (Figure 13). Ageing data has not been completed since 2009; hence the time series ends in 2009.

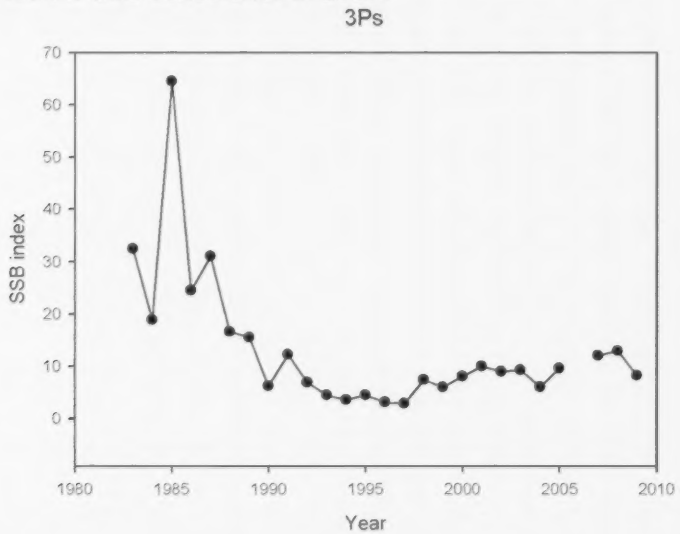

Figure 13. Subdiv. 3Ps American Plaice index of spawning stock biomass derived from research vessel surveys.

Recruitment

For Subdiv. 3Ps, a relative recruitment index estimated from surveys using a general linear model applied to ages 2-5 declined from 1980 until 1995 (Figure 14). Since then it has increased fairly steadily to reach levels similar to the beginning of the time series.

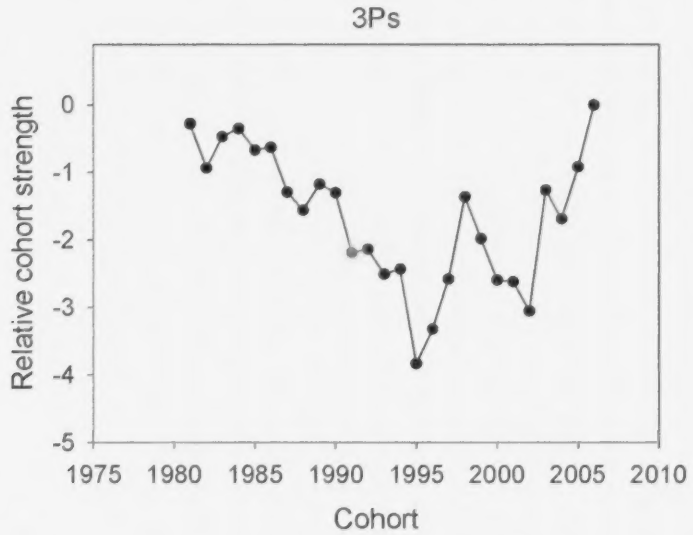

Figure 14. Subdiv. 3Ps American Plaice recruitment as relative cohort strength estimated from research vessel data. Estimates are relative to the 2006 cohort.

Reference Points and Current Status

A Bayesian Surplus Production Model was applied to catch data from 1960-2010 and survey data from 1980-2010 for American Plaice in Subdiv. 3Ps. Production models estimate relative levels of biomass and fishing mortality more precisely than absolute levels. This means that the ratio of biomass to the biomass giving maximum sustainable yield (B_{msy}) and the ratio of fishing mortality to the fishing mortality giving maximum sustainable yield (F_{msy}) are more precise than biomass and fishing mortality themselves. For this reason, stock trajectories and reference points are usually reported as these ratios (B_{ratio} and F_{ratio}) and status determined relative to F_{msy} and B_{msy}, with the biomass limit reference point set as a percentage of B_{msy}. Consistent with the DFO PA framework, B_{lim} (the biomass limit reference point) is 40% B_{msy}, (where B_{msy} is the equilibrium biomass that can produce the maximum sustainable yield), the upper stock reference is 80% B_{msy} and F_{lim} (the removals reference point) is F_{msy} (the equilibrium fishing mortality that can produce B_{msy}). Stock status relative to these reference points was estimated from the model.

Stock size estimated from this model has been increasing slowly since 1993, however, the current median biomass is 50% of B_{lim} and therefore the stock is in the critical zone (Figure 15). Taking uncertainty into account, the probability of being below B_{lim} is high (0.94). Current median fishing mortality is estimated to be 64% of F_{lim} (Figure 16). The probability of being above F_{lim} is relatively low (0.2).

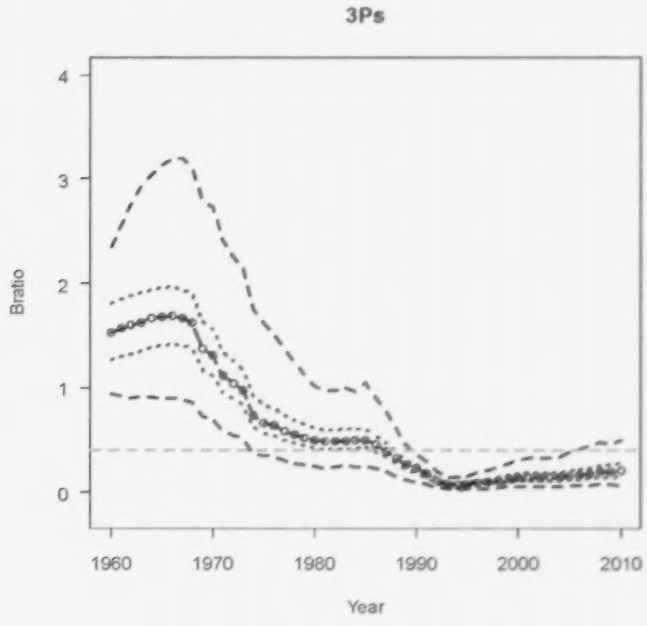

Figure 15. Subdiv. 3Ps American Plaice. Estimated ratio of stock biomass to B_{msy} from surplus production model. The median, 70% and 95% credible intervals are shown. The red horizontal line is B_{lim} (i.e. 40% of B_{msy}).

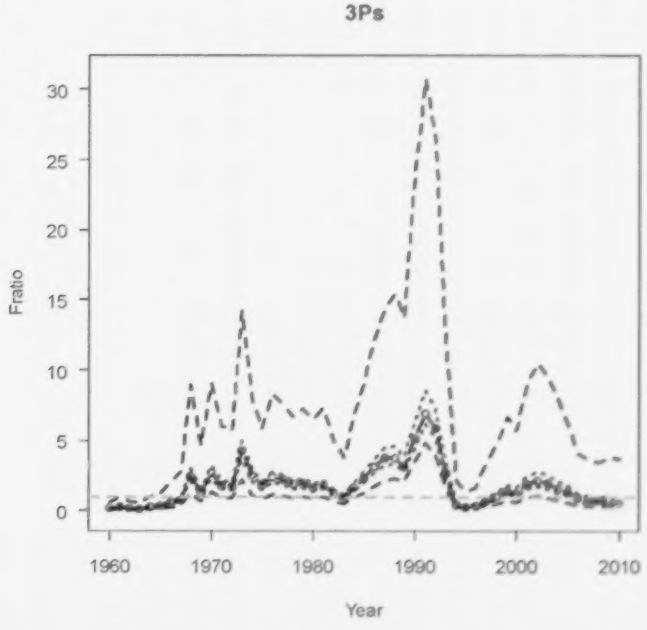

Figure 16. Subdiv. 3Ps American Plaice ratio of fishing mortality to Fmsy from surplus production model. The median, 70% and 95% credible intervals are shown. The red horizontal line is F_{lim} (where F_{ratio}=1).

Sources of Uncertainty

Estimates of SSB, recruitment and mortality from DFO surveys were not available beyond 2009 for this meeting due to a backlog in age interpretation of samples.

There are discards of SA2+Div.3K American Plaice from the shrimp fishery, mainly of fish less than 30 cm; however the magnitude of these discards is not known. Incomplete observer coverage of directed fisheries in each area means that American Plaice by-catch and discards in these fisheries are uncertain.

Sampling of the commercial bycatch age/size composition for Subdiv. 3Ps American Plaice has not been representative in most years since the moratorium as gill net bycatch (which takes a large proportion of the bycatch) is not adequately sampled.

It was not possible to use an analytical model of population dynamics for American Plaice in SA2+Div. 3K at this time. Therefore the biological limit reference point is based on survey data only and it was not possible to determine an upper reference point or a removals (F-based) reference point for this stock.

A new model was applied to Subdiv. 3Ps. Although this model is accepted as the basis for the assessment and reference points for this stock, further work is required to better explore the sensitivity of the model applied to this stock to the assumptions. In particular, sensitivity to priors needs to be further explored.

CONCLUSIONS

It was not possible to use an analytical model of population dynamics for American Plaice in SA2+Div. 3K at this time. Therefore an empirical biological limit reference point (LRP) was determined from examining stock recruit data from the RV survey, and this indicated that, in general, recruitment has been impaired when the survey SSB index is below 70 000 t, which was chosen as the LRP. The 2009 estimate of survey SSB indicates that the stock is at 24% of the LRP.

For American Plaice in Subdiv. 3Ps, a Bayesian Surplus Production Model was applied to catch data from 1960-2010 and survey data from 1980-2010. Consistent with the DFO PA policy B_{lim} is 40% B_{msy}, the upper stock reference is 80% B_{msy} and F_{lim} is F_{msy}. Stock size estimated from this model has been increasing slowly since 1993, however, current biomass is 50% of B_{lim} and therefore the stock is in the critical zone. The probability of being below B_{lim} is high (0.94). Current fishing mortality is estimated to be 64% of F_{lim}. Taking uncertainty into account, the probability of being above F_{lim} is 0.2.

LRPs for American Plaice in SA 2+3K and Subdiv. 3Ps may be revised as more data become available.

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Regional Peer Review meeting of March 20-21, 2012, An Update of Stock Status and Determination of Limit Reference Points for the American Plaice stocks in i) NAFO Subarea 2+ Division 3K, and ii) NAFO subdivision 3Ps. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

DFO. 2009. A Fishery Decision-Making Framework Incorporating the Precautionary Approach (http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/precaution-eng.htm).

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ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)
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CORRECT CITATION FOR THIS PUBLICATION

DFO. 2012. Reference points for American Plaice (*Hippoglossoides platessoides*) in NAFO Subarea 2 + Division 3K and Subdivison 3Ps. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/025.